EPSC Abstracts
Vol. 6, EPSC-DPS2011-418, 2011
EPSC-DPS Joint Meeting 2011

Energetic electron observations of Rhea's magnetospheric interaction

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Abstract

Rhea is one of Saturn's largest moons, orbiting the planet in the inner edge of the ring current. The dominant mode of Rhea's magnetospheric interaction is thought to be plasma absorption, meaning that the interaction region should be present only downstream of the moon and in a region not much wider than Rhea's corotational wake. Still, data from Cassini's three closest flybys to that moon are rich in very unusual interaction features, mostly in the energetic electron dataset. These features, which have depletion-like characteristics and appear on various spatial scales, have been initially interpreted as evidence for the presence of dust concentrations in trapped orbits around Rhea. This interpretation, however, has not been independently verified by other means of observations. In this presentation, we will present details of energetic electron observations from these three closest Cassini flybys to Rhea and we will test alternative scenarios for interpreting this complex dataset. More specifically, we show results of a phase-space density analysis, looking for evidence of energetic electron transport processes in the vicinity of Rhea's wake. We also perform energetic electron trajectory tracings in order to map regions where access of energetic electrons in Rhea's interaction region is forbidden. Such regions form because of complex energetic particle magnetic drifts downstream of Rhea, where the magnetospheric electric and magnetic fields are disturbed. We show that while our approach provides some qualitative explanation for some of the observations of electrons with energies above 100 keV, the lowest energy features in the MIMI/LEMMS dataset (20-100 keV) cannot be explained, especially those that extend upstream of Rhea and in a region that a plasma absorbing moon should, in theory, have no effect on the magnetospheric populations. Given that, in addition to the fact that Rhea orbits in a region of the magnetosphere that is thought be unstable against centrifugal interchange, we propose that the formation of Rhea's wake acts as a disturbance that helps enhance local magnetospheric interchange. Interchange driven disturbances, may then actually be the source of some of the unusual energetic electron observations. We also discuss this scenario in the context of additional published observations by the Cassini's cold plasma detector.